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ABSTRACT

Recent changes at institutions of higher education in America have caused new interest in faculty development. This paper is concerned with faculty development in the sciences and engineering and is a report submitted to the National Science Foundation (NSF). The contents include faculty development: (1) general perspectives; (2) in the sciences and engineering; (3) in different types of institutions; (4) through regional and national agencies; (5) support by funding agencies; (6) recommendations for NSF; and (7) references. (MA)

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FACULTY DEVELOPMENT IN THE SCIENCES AND ENGINEERING

A Report Prepared for the National Science Foundation

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A. INTRODUCTION

Faculty development has gained wide acceptance during the past five years in American higher education as a vehicle for the improvement of teaching and learning. Currently, about one half of the colleges and universities in the United States that responded to a nation-wide questionnaire offer some form of faculty development services (Centra, 1976). Furthermore, we estimate that at least $50 million has been given by governmental agencies and private foundations during the past five years to support the creation or expansion of faculty development programs in this country. Several years ago, the Chronicle of Higher Education reported on an "explosion" in the field of faculty development. This trend has continued and apparently will continue for at least two or three more years. Even more important, faculty development probably will become imbedded as a permanent academic service of most colleges and universities.

The increased interest in faculty development can be attributed to at least four causes. First, students are becoming increasingly heterogeneous. They now come from lower socio-economic classes, from an older age group and from different racial and ethnic backgrounds. The "nontraditional" student enters the collegiate institution with a different set of needs and expectations, and different learning styles. Faculty must respond to this heterogeneity with a more diverse and flexible set of instructional goals, attitudes and strategies.

Second, colleges and universities can no longer operate in splendid isolation. They have become increasingly accountable to the general public, trustees, or a sponsoring church. Within the institution, evaluation of professional performance reflects this increased sense of accountability. If faculty are to be evaluated, then they must also be given an opportunity--and the resources--to improve this performance in areas where deficiencies are noted. If they are not provided with these opportunities and resources, the evaluative process becomes inherently unfair and destructive.

Third, faculty are becoming less mobile as more of them become tenured and fewer of them find an opportunity to move to another college or university. The majority of faculty in American higher education will be teaching at the same institution for the next twenty to thirty years. Colleges and universities must devise professional development programs that help these entrenched faculty remain vital and excited about their work. Since we have become more fully aware of the stress associated with stagnation in one's career (Levinson et al., 1974) the challenge of rejuvenating faculty in "mid-career crisis" (Hodgkinson, 1974) is even more pressing.

Fourth, as enrollments in traditional liberal arts colleges and universities drop off, there is increasing competition for students among these institutions. This competition has already produced many significant curricular changes (for example, external degree programs, competency-based instruction and new work-study arrangements). These pressures for change in the basic educational structures of many colleges and universities require a program

within the institution which supports and assists faculty in accommodating to and even helping to bring about these changes. Such a program must be responsive to the needs of the faculty member as a professional (instructor, advisor, educational designer), a person (life and career planning, interpersonal skills) and a member of an organization (team building, conflict-management)(See Appendix A).

Like their colleagues in other disciplines, faculty in the sciences and engineering must face these demands for change and renewal. Furthermore, since many areas in the sciences and engineering are not now growing in terms of student enrollment or public financial support, these demands for change and renewal must be met without significant external support (money, people, time, machines). Furthermore, very few external incentives (major pay increase, promotion, career advancement) are available to promote change and renewal, for many faculty in the sciences and engineering are already at the top of the academic career ladder (tenured, full professor), having achieved this status at a young age in the post-Sputnik era. Science and engineering faculty must find resources for change and renewal from among themselves and must find reasons for change from new sources that are often internal in nature (renewed interest in teaching, new developments in the discipline or between disciplines, reawakened interest in students).

Practitioners in the field of faculty development face an imposing challenge in working with faculty from the sciences and engineering. This paper is directed toward the review of strategies and resources that are now or could be used to meet this

challenge. We will first provide a general perspective on faculty development practices, then specifically examine the developmental needs of faculty in the sciences and engineering. From a third perspective, we will discuss differences in faculty development practices at small and large, private (independent) and public (state-supported) institutions. Fourth, faculty development will be discussed as it has been conducted by regional and national higher education agencies. Finally, we will consider several ways in which faculty development has been supported by national-level funding agencies. We conclude the paper with a brief listing and discussion of eight recommendations to the National Science Foundation.

B. GENERAL PERSPECTIVES ON FACULTY DEVELOPMENT

Faculty development is not a new area of activity in American higher education, though it has taken on new dimensions and emphasis during the past decade. Traditionally, faculty development has been equated with faculty leave policies and sabbaticals, the allocation of funds for travel to conferences, the provision of support (financial, time, personnel) for research and scholarship, or the purchase of instructional equipment (audio-visual aids, teaching machines, instructional software for computers). None of these approaches has seemed to be satisfactory, given the changing conditions described above.

Faculty have been notably reticent to make use of instructional technological breakthroughs--even if they themselves are faculty in technological fields. As a result, some instructional technologists in the early 1970's began more actively to assist faculty in the design of instructional units or entire courses that effectively

integrate the technologies that are available (Diamond et al., 1975). In this way, the "instructional development" field began to expand and gain credibility. Though instructional development has generally grown independently of the faculty development movement, the two are now becoming interrelated and interdependent.

Many faculty and administrators have also become dissatisfied with the research and resource allocation programs. They want a developmental program that crosses disciplinary boundaries and emphasizes instruction and broad intellectual growth. This attitude has been most forcefully and influentially articulated in a publication by Change Magazine entitled Faculty Development in a Time of Retrenchment (Astin, et al., 1974). A summary description of the contents of this brief report conveys something about the field of faculty development in 1974:

1

The Need for Faculty Development

Professional stagnation among American faculty is in danger of replacing faculty mobility. Wringing more out of declining resources makes adequate teaching supports on a major scale all the more essential to assure faculty development through the end of this century.

2

Kinds of Reform

Why some old devices to encourage good teaching don't work, and what strategies may be used to achieve substantial improvements in the quality of college teaching. Some practical and reasonable departures from current practice can substantially enhance the professionalization of teaching.

3

Teaching as a Performing Art

Teaching, unlike research and publishing, remains very much a private professional act, rarely open to collegial scrutiny. Effective teaching remains a stepchild in the hierarchy of academic goals and values. It could be greatly improved by opening up the process to sensible and substantive criticism.

4

Knowledge About Learning

Self-reflectiveness about the processes of teaching and learning can become a viable instrument for teacher and student alike. Such awareness is rarely present today. An institutionalized intellectual concern for the nature of learning may represent the last remaining bit of common culture in the modern, diffused multiversity.

5

Training Future Professors

Few graduate schools prepare their students for teaching in any practical sense, leaving classroom performance largely to change. A new teaching practicum, new teaching degrees, and the encouragement of intellectual work directed toward the classroom are some devices to upgrade current teaching effectiveness.

6

Campus Programs on Teaching

Most campuses suffer from an anemic pedagogical culture. New institutionwide programs for teaching would counteract the present undernourishment. Campus teaching institutes may be one remedy. If they are carefully planned, such teaching centers can produce a number of benefits of long-range significance both to participants and institutions.

7

The Role of Experts

Pedogogic development through teaching institutes may be further enhanced by teaching consultants from the outside, used in a suitable mix with the campus faculty. Expertise in this area should be utilized wherever it is available.

8

Evaluation for What?

The great game of grading offers relief from the ambiguities of learning, but the two should not be confused. Good learning presumes a vulnerability, which grading as a sorting-out process often prevents. A separation of the two is possible, with third-party assessment of both students and teachers performed in an atmosphere of confidentiality.

9

Grants for Teaching

National resources for enhancing pedagogical competence are woefully lacking, and grants should be provided similar to those given for research. The dual hierarchy of quality teaching and intellectual work and research needs to be legitimated, with grant dollars attached to both.

10

Intellectual Mobility

It is harder to improve an existing job than to move to a new one, but diminished faculty mobility may provide opportunities for inplace enhancing of professional competence. Multiple professional identifications, rather than identification only with one's own discipline, is a break with academic traditions that would provide networks of interests and intellectual integration.

11

Mid-Career Transitions

Providing insurance mechanisms to allow mid-career transitions into nonacademic work could make a very large difference to academic institutions in the late twentieth century. Intercampus faculty exchanges and provisions for mixing academic with nonacademic employment would also enhance academic performance in a period of contraction.

12

Ways to Begin

Seven key recommendations, and a discussion of how they would work. Strategies on how to begin revitalizing campus teaching, their hazards and their pay-offs. If the sixties was the decade of growth, the seventies and eighties can well become the decades of resourcefulness.

1. Colleges and universities should organize regular campus programs on teaching coordinated by an institute . . .

2. . . . the campus institute (at universities which grant advanced degrees) should supervise a teaching practicuum undertaken by graduate students in the course of their work for the Ph.D. or other degrees that lead to work in college teaching.

3. Graduate students should be able to have their teaching officially evaluated for the record by methods that aim to be as sophisticated as those used to judge their scholarship . . . Entirely separate from these official evaluations, the teaching institute should provide confidential assessments of work done by graduate students and professors alike.

4. . . . college students should be graded for the record by people other than their own teachers.

5. Professors should have access to small grants for special teaching projects.

6. Institutions should loosen the present monopoly departments now hold over both professional time and the "fields" of knowledge.

7. In mid-career some professors develop nonacademic ambitions, want to switch to another field within academic life, or become disinterested in teaching . . . we need a system of insurance for mid-career changes . . .

These recommendations, while valuable, are incomplete. They inadequately touch on the significant personal and organizational changes that must accompany or even precede significant changes in the teaching and learning processes of a college or university. Furthermore, since most collegiate institutions no longer are hiring many new faculty, an emphasis on the development of graduate students as teachers may be misplaced: attention should be directed toward those faculty who are now teaching and will be teaching for another twenty or thirty years.

An effective program for faculty development must be respectful of three different strategies for change (Lindquist, 1977): (1) the creation and demonstrated applicability of new knowledge (research and development) (2) the creation of channels for the dissemination of this knowledge (social interaction) and (3) the establishment of conditions within organizations that promote the effective use of new knowledge (problem-solving). Specifically with regards to faculty development, some programs should emphasize research and development: the study of instructional processes in the college classroom or a test of new approaches to the improvement of instruction. Typically, this type of faculty development program resides in an institute at a prestigious, research-oriented university. This dimension of planned change is fully compatible with the rational and empirical norms and mission of American higher education, hence is

readily accepted by most faculty and administrators. In isolation, however, this strategy will have only limited impact on the daily professional lives of faculty.

A programmatic emphasis on the dissemination of new knowledge usually involves workshops and conferences where faculty are brought together to hear about or discuss new ideas and experiences, or networks through which faculty are linked with relevant and knowledgeable resources (people, books, programs). While this strategy for change is essential if faculty are to be kept informed and intellectually alive, it does not adequately address the problem of use: how does a faculty member employ these ideas, experiences or resources back in the classroom or laboratory?

The third strategy, problem-solving, primarily touches on the process rather than substance of change: how can we create settings in which new ideas and the experiences of other people become readily integrated into the life of an organization or institution? Faculty development programs can employ this strategy by training faculty in the use of new methods, helping an academic department prepare for a major instructional innovation or determining why a curriculum committee is unable to take action on a new plan. This third dimension is essential to significant planned change, yet it is not sufficient. Without the other two strategies, there are no new ideas to be used by a college or university in confronting changing student needs and societal conditions. One must, therefore, create a faculty development program which links and integrates research, development, dissemination and use.

At a somewhat more specific level, several different sets of strategies and components for faculty development programs have been identified. Bergquist and Phillips (1975) listed eleven such strategies (See Appendix B):

1. Training: giving faculty new skills that can be used in the performance of specific tasks, like teaching, or in the accomplishment of change itself.

2. Consultation: assisting faculty to define a problem, to discover resources to use in solving this problem, to use these resources and to evaluate the effectiveness of the problem-solving effort.

3. Personal and organization development: helping a faculty member to plan for and manage change.

4. Method-promotion: encouraging faculty to use specific instructional methods or technologies.

5. Instructional design: helping faculty to plan for and implement new instructional programs.

6. Equipment: providing faculty with new resources for instruction.

7. Discussion: providing a setting in which faculty can readily talk about their teaching.

8. Evaluation: developing and/or administering instruments for the assessment of instructional performance by faculty.

9. Reward systems: developing a policy for equitable and objective assessment of job performance, a set of resources for improvement of performance and tangible rewards for the improvement.

10. Career transitions: helping faculty to move to a new discipline or job outside higher education, and

11. Comprehensive institutional development: coupling faculty development with other programs that assess and/or confront the needs of the institution.

Several other attempts have also been made to identify the diverse activities that comprise a faculty development program. David Brown and William Hanger (1975) offer a list of 142 self-development activities that can be employed to "stimulate the faculty members

and to strengthen the institution" (See Table 1). John Centra (1976) identified forty-five faculty development practices when constructing a survey questionnaire for the determination of frequency and effectiveness of these practices (See Table 2).

In a somewhat more systematic manner, Sikes and Barrett (1976) classified faculty development practices on the basis of level and and type of activity (See Table 3). They identified three different levels: personal/individual, interpersonal/group and intergroup/organization. The types of activities include: facilitative/process (helping faculty improve the way they relate to one another, students or other members of the institution), structural/technical (providing faculty with time, space or physical resources), expert/knowledge (giving faculty new and more information) and research and development/demonstration (generating new information or proving the validity of existing information).

Another systematic listing of activities (See Table 4) has been provided by Bergquist and Phillips (1974, revised: 1976) based on their three-fold distinction between instructional (professional), personal and organizational development (See further: Appendix A). This list recently has been updated (See Table 5) to incorporate a broader list of activities and to reflect the observation that some of the most effective faculty development practices incorporate a community development approach to change (See further: Appendix D) or involve change at an institutional or multi-(meta)-institutional level (See further: Appendix C).

What do these various lists and categorizations tell us about faculty development? First, they tell us that faculty development is many different things, and therefore is difficult to clearly define or label. These lists also tell us that we now have a

rich source of ideas and learnings from which to borrow when confronting complex institutional problems. Because of the disorderly condition of these sources of information about how to effect faculty growth and development, we are faced with the difficult task of training faculty (and administrators) to become practitioners of faculty development in our colleges and universities. Trial-and-error learning no longer seems appropriate, for we are no longer ignorant about how to do faculty development. We cannot yet be sure, however, about how a faculty development practitioner can best be prepared to meet a diversity of conditions and needs. At this point, practitioners face the prospect of continuing--though not substantial--support for faculty development activities. Several years ago, Jerry Gaff (1975) described the current and ideal status of faculty development programs (See Table 6). His conclusions still seem to hold true: there are significant discrepancies between current and ideal conditions.

In several ways, the National Science Foundation can help sustain and expand the developmental services offered to faculty in the sciences and engineering. In setting the context for these recommendations, we will first identify those needs of science and engineering faculty and different kinds of colleges and universities that appear unique and require specialized faculty development practices. We then will examine the support of faculty development activities by regional and national agencies.

C. FACULTY DEVELOPMENT IN THE SCIENCES AND ENGINEERING

Generalizations about faculty in the sciences and engineering are not easily drawn given the great diversity to be found among

these faculty in instructional and professional goals and concerns. When contrasted with faculty in other areas of academic life (for example, the humanities and arts), however, science and engineering faculty do seem to share certain characteristics, problems and sources of gratification.

Perhaps most important, there is a dominant concern among faculty in the sciences and engineering about the content of their discipline. These faculty face a constantly changing discipline, as knowledge continues to explode and new areas of specialization emerge. Whereas a faculty member in literature can at least "get by" teaching a course on Shakespeare without having read anything new in the past five years, a faculty member in physics, biology, psychology or electrical engineering would be unable to remain inactive for even one year. Thus, scientists and engineering are forced to keep up in their discipline. This dominant concern yields several important implications.

First, in order to keep pace, many faculty in the sciences and engineering attempt to become increasingly specialized--learning more about less. In small colleges and teaching-oriented universities, however, the luxury of specialization cannot be afforded. Faculty must be generalists--they are responsible for introductory courses, and in recent years often primarily provide service courses for students who are majoring in other disciplines or are preparing for a profession (medicine, social work and so forth). The task of keeping up for these faculty becomes even more difficult: many faculty must resort to reading the latest edition of an introductory textbook in order to keep abreast of new development in their discipline. There should be better

ways for a faculty member to remain knowledgeable in his field. The traditional delivery systems for new knowledge (annual conventions, journals) apparently are not adequate for keeping faculty up-to-date.

In the minds of many, there is an appropriate sequence to specific disciplines (e.g., mathematics); students need to learn certain information, in certain sequences, in order to become satisfactorily prepared for work in the discipline. If students don't acquire a very specific background in a course then they will not be able to advance to the next course in the sequence. Thus, there is little room for educational innovation or freedom of choice among students in the order and manner in which they learn new material.

During the 1970's, the emphasis on time-shortened degree programs, such as those advocated by the Carnegie Commission, were viewed with great apprehension by many science and engineering faculty. A full four or five years are needed to adequately prepare a professional scientist or engineer. Similarly, these faculty now tend to resist a reemphasis on the liberal arts and an expanded core curriculum. This trend represents an intrusion into the essential curriculum of the sciences and engineering.

The third implication of the emphasis on content concerns the dominant role played by the disciplinary organization and by prestigious researchers and scholars in the field. These are not only the primary sources of new knowledge, and primary disseminators of this new knowledge, but are also the legitimizers of instructional innovations. If one examines the major changes in the teaching of science or engineering during the past decade, one finds that these changes have usually been supported by one of the major disciplinary

associations and/or by one or more faculty members at major research-oriented universities who are held in esteem by faculty in the field. Typically, a successful researcher becomes interested in science or engineering education. He gets a large grant to try out a new (or unacknowledged) instructional innovation. Other faculty soon pick up on this innovation--usually through attendance at a national conference--and try it out in the classroom or laboratory. Faculty development must be supported by major leaders in the field and by disciplinary organizations if it is to be successful.

Fourth, the dominant concern for keeping up-to-date in the discipline has generally led to a neglect of instructional and interdisciplinary issues--the major thrust of faculty development in the mid 1970's. As a result, faculty in the sciences and engineering have generally been less receptive to faculty development than have been faculties in many other fields. Many of the disciplinary organizations are only now beginning to ask the basic questions about the need for and goals of faculty development (questions that were asked several years ago in many other disciplines). The American Association for Engineering Education, for instance, is only now beginning to organize a committee on faculty development. Much of the work that could be described as faculty development in the sciences and engineering can be attributed to the National Science Foundation.

Finally, the emphasis on content seems to either attract or create a certain type of student/teacher relationship. Both students and faculty are primarily interested in content: a search for information and "truth" rather than alternative perspectives and relativistic analyses. In general, the students

are not being taught--nor seem to want--open-ended material. Below the senior or graduate level, problems are presented which usually have a right and wrong answer. Students are taught to view problems in a specific way (the "scientific method"). If a problem cannot be viewed in this way, it is ignored. In a very real sense, faculty in both the sciences and engineering are engaged in skills-training. Students want to be told, rather than discover (though this feature is certainly not unique to science and engineering education).

Science and engineering faculty also tend to be oriented toward the analysis rather than synthesis of the content they are conveying: students learn to study and understand the pieces or components of a phenomenon without necessarily being able to recognize and appreciate the phenomenon in its totality. A majority of scientists seem to be convinced of the objectivity of science, while often failing to recognize its subjective aspects. As a result, faculty and students often fail to view their discipline in the relativistic context of history and culture (Kuhn, 1962).

During the past five years, this perspective has been increasingly challenged by the "new" and "nontraditional" students: minorities, women and older people. These students are often viewed as ignorant, ill-prepared or ill-equipped by the faculty, for they tend to view scientific or engineering problems in different, and often broader, contexts. Even scientists and engineers who are returning to campus for continuing education are often viewed with suspicion (and fear) by the faculty. In general, faculty teach most effectively to the same kind of student that they are. As the student population becomes more

heterogeneous, faculty must become increasingly concerned with instructional and attitudinal issues, thereby at least temporarily abandoning their dominant concern for the rational and objective accumulation of knowledge in their field.

A second major area of unique concern to faculty in the sciences and engineering concerns the purchase, use and justification of equipment for research and instruction. Quite clearly, education in the sciences and engineering is more expensive than education in most other fields. As in the case of the performing arts, the sciences and engineering often require small student-faculty ratios; in addition, however, they require laboratory equipment and supplies, laboratory assistants, space that cannot readily be converted for other purposes, and lengthy class periods. A comparison with the course on Shakespeare can again be drawn: Shakespeare can be taught almost anywhere, at very little cost (a copy of the work), whereas most courses in the sciences and engineering can be taught in only certain settings, at considerable cost. Several implications arise from this condition.

First, faculty in the sciences and engineering must justify costs of instruction by demonstrating that this instruction yields significant benefits. While these benefits were rather easily demonstrated and accepted in the post-Sputnik era, they no longer are--especially given declines in student enrollment in many of the sciences and engineering, and declines in the demand for new practitioners in some fields.

The costs of instruction requires that science and engineering faculty be able to clearly document the success of their students

in acquiring essential competencies in the field. Furthermore, science and engineering education (particularly the latter) are uniquely accountable to the professions for which students are being prepared: the professional associations have a definite say about the content and process of instruction. Thus, faculty in the sciences and engineering must be able to demonstrate benefit to not only the college or university community that is worried about high costs, but also the professional community that is worried about the quality of new entrants into the profession.

The teaching scientist or engineer must confront a second equipment-related problem as well. Sophisticated research equipment could be used for instructional purposes. However, for whatever reason faculty members lack the use of theory in applying these pieces of equipment to instruction. Frequently, faculty do not know how to design an effective laboratory experience. They fall back on "cook book" approaches to laboratory education that teach a student how to follow instructions, but do not teach him how to think or solve problems. Faculty must be provided with opportunities and resources to learn about alternative approaches to laboratory education (for example, individualization of laboratory education through the use of audio-tutorial devices) and the instructional use of equipment (for example, the use of computers to simulate laboratory experiences).

As a means of reducing instructional costs for laboratory education, many colleges and universities have reduced the number of hours credit that faculty receive for conducting or supervising the laboratory. As a result, many faculty do not have

adequate time to prepare for the lab or must assign most laboratory work to undergraduate or graduate teaching assistants. The reduction in institutional support for laboratories often is interpreted as a depreciation in the value of this type of learning. Consequently, the science and engineering laboratory has become a "second-class citizen" at many colleges and universities.

High instructional costs have also restricted the type of institution that can offer instruction in the sciences and engineering (especially the latter). An engineering faculty is necessarily rather large, for the capital investments required for a minimal laboratory can only be provided if the program will accommodate many students. Similarly, many of the laboratory sciences cannot be adequately serviced in small colleges. One of the unfortunate side effects of this restriction is the absence of science and engineering faculty in those environments (small colleges) which are most conducive to interdisciplinary dialogues among faculty as well as a pervasive concern for the integration of values and course content--two areas of development which are clearly needed in many of the sciences and engineering.

Small colleges must be given assistance in finding the capital resources for development of science and engineering programs. We must find new ways, as well, of reducing laboratory costs (for example, through use of laboratory facilities in industrial settings) or of integrating or exchanging the resources of small and large collegiate institutions (for example, faculty exchanges between small, liberal arts colleges and large, research-oriented universities).

A third area of unique concern for faculty in the sciences and engineering relates to their professional self-definition. First, many faculty in these fields quite rightfully view themselves as being at the top of the academic pecking order. These disciplines (especially the physical sciences) are usually viewed with respect by colleagues in other fields. The science and engineering faculty member often feels that he could master any other field with the tools of his current discipline. Members of other disciplines borrow terms from the sciences and engineering to gain respectability for a concept. Students in the sciences and engineering are usually viewed as more "serious" and are generally regarded as "better" students than are those enrolled in other majors.

Being at the top of the heap, many scientists and engineers seem unwilling to risk alternative approaches to instruction or interdisciplinary studies. Furthermore, many of these faculty reached their creative and productive peak in the early 1960's. They are still relatively young men and women (40-50 years of age), yet perceive themselves as being on the decline in their professional lives. While many faculty in other fields are similarly past a period of peak production and creativity, this fact is not as obvious or painful, for they have not known a position of high esteem in the academic community as have the science and (to a lesser extent) engineering faculty.

Faculty in the sciences often do not perceive themselves to be teachers, but instead view themselves as scholars or researchers: they tend to identify themselves as "cellular physiologists", or "developmental psycholgists", rather than as "faculty members", "teachers"

or "educators." Faculty in engineering, as in other professional training programs, tend also to perceive themselves as members of the profession rather than as members of the higher education community. Since they usually sacrificed salary and even prestige to become teachers, however. the engineering faculty often seems to be more amenable to concerns about instruction than are their colleagues in the sciences.

While this last feature--the self-definition of faculty as members of a discipline--is not unique to science and engineering education, it takes on new significance when coupled with the previously-discussed features. To the extent that faculty in the sciences and engineering are concerned about instruction, they tend to be concerned about mastery of content that they are teaching or about obtaining adequate financing to keep a laboratory program afloat. These concerns could translate into significant instructional innovations, yet such innovations usually require support from those faculty and disciplinary organizations that are primarily oriented toward research and scholarship. A faculty development program in the sciences and engineering must be responsive to these complex conditions by being respectful of traditions and the disciplines, yet seeking to establish a new awareness of and support for the broader, interdisciplinary issues of teaching and learning.

If we examine the faculty development activities that are currently found in the sciences and engineering several of these unique features become even more apparent. First, most faculty development for scientists and engineers has been provided through a program specifically designed for faculty in these

fields. Furthermore, faculty in the sciences and engineering generally have not been among the most active participants in these campus-wide programs.

Second, as one might expect from our previous discussion, most of the faculty development programs specifically for the sciences and engineering focus on content updating within the discipline (for example, the NFS Chautauqua conferences) or on the use of new instructional designs or technologies (for example, Postlethwaite's program at Purdue University for the training of science faculty from throughout the country in the use of audio-tutorial procedures). There has been much less concern about the diagnosis and improvement of instructional skills, the examination of faculty attitudes about instruction or career development, or the improvement of departmental or program planning and implementation to effectively accommodate instructional innovation.

Some of the most significant and thoughtful innovations in science and engineering education have failed not because the idea was without merit but because the idea was not effectively introduced into the institution and/or because the faculty who were to employ this innovation were not brought into the process at an early point or were not effectively prepared for the use of the innovation. Appendix E contains a case history of just such a failure: the discontinuation of a new PSI program in the introductory physics courses at the Massachusetts Institute of Technology. Alternative approaches to faculty development in the sciences and engineering must be explored and integrated with concerns for content and instructional design.

D. FACULTY DEVELOPMENT IN DIFFERENT TYPES OF INSTITUTIONS

Just as there are important differences in the developmental concerns and needs of faculty in the sciences and engineering as compared to faculty in other disciplines, so there are significant differences among faculty in different types of colleges and universities. We will be able to touch on only a few of these distinctions. A volume now being written by several of the authors of this report will describe these differences in more detail.

The most important difference seems to be between faculty from small and large institutions, regardless of whether or not the institutions are public (state-supported) or private (independent). First, in the small college there is usually a greater sense of community than is found in the large university. There is often a greater sense of alienation and "commuterism" among faculty in the larger universities. Conversely, more resources are available to faculty in the large university, and these faculty are exposed to more diversity and are usually freer to explore their own individual interests and concerns. Faculty in the small college are more likely to be isolated and parochial in their intellectual and instructional perspectives. There is also a greater chance for conformity and stagnation among faculty in the small college. While faculty in large universities are more likely to experience anomie, small college faculty are more likely to sense an invasion of privacy.

In general, there is a greater potential for programmatic or institutional change in the small college: faculty development can and often has made a significant difference in the lives of

faculty at these colleges. On the other hand, the individual faculty member in a large university can usually "get away" with more than can the small college faculty member, especially if he is tenured. He also has more resources and expertise available to make this change successful than does the faculty member in the small college. In the large university, one finds that faculty development usually has only sporadic and unpredictable impact on faculty who are often already involved in innovation and instructional experimentation.

A comparison between independent and state-supported institutions reveals several important differences among faculty. The independent college or university often has a clearer sense of mission, especially if church-related, than does the state-supported institution, which must be responsive to multiple constituencies. As a result, faculty in independent institutions usually have a somewhat clearer sense of what is expected of them and what they should do to improve the quality of teaching and learning at the college or university. A clear mission statement also allows these faculty (and administrators) to more readily bring about significant curricular or institutional change.

Secondly, the independent college or university is generally more amenable to an integration of values and education, or personal and professional needs and interests. The state-supported institution must be more sensitive than the independent to diverse values-systems in the community. To the extent that faculty development involves the exploration of educational values and/or the exploration of personal dimensions in one's professional

life, the independent college will generally be more supportive of faculty development, and the environment of this college more conducive to this type of service.

The state-supported college and university must generally be more responsive to the changing needs of students and society. The state or community college usually must be open to a more diverse student body than the independent college. As a result, program and curricular offerings must be more diverse at the state-supported institution. These colleges and universities are also more directly accountable to off-campus constituencies: disciplinary associations, business interests, union interests, legislators, judges and so forth. Both public policy and governmental regulations also have a significant impact on the programs and curriculum of a state-supported institution--though independent college and universities certainly are not immune to these policies and regulations.

These differences between independent and state-supported institutions yield something of a paradox: the state-supported college and university faculty probably are more in need of professional developmental services since these institutions are more vulnerable to pressures for change and renewal; yet, conditions in the independent college and university are more amenable to faculty development and faculty in these institutions are generally more supportive of this type of activity.

Given the problems and potentials associated with faculty development in each of these different types of institutions, it is essential that regional and national agencies cooperate in their provision of services to these colleges and universities.

An increased sharing of expertise and resources between small and large, independent and state-supported institutions cannot help but be of benefit to all members of the higher education community. We now turn to an examination of these and other services that can be provided in the area of faculty development by regional and national agencies.

E. FACULTY DEVELOPMENT THROUGH REGIONAL AND NATIONAL AGENCIES

The role played by any regional or national higher education agency in the area of faculty development is necessarily limited, for the integrity of the institution and the autonomy of the individual faculty member must be respected. Staff or consultants representing a regional or national agency should rarely work in the classroom of an individual faculty member--unless for demonstration purposes. This type of on-site consultation should be provided by colleagues or an in-house specialist. Similarly, a regional or national agency representative should rarely be involved in on-going work with faculty on personal, career or organizational problems outside the classroom, unless, once again, this service is being provided for demonstration purposes (a notable exception is the excellent career-counseling done by Fred Gaige when he was a member of the staff at the Kansas City Regional Council for Higher Education).

A wide variety of activities and services, nevertheless, are still open to a regional or national agency. We have identified eight such activities or services: (1) providing direct consultation to college and universities on broad organizational or institutional issues, (2) providing intensive residential workshops for faculty from two or more institutions,

(3) helping to arrange for inter-institutional exchange or sharing of human or physical resources, (4) assisting a college in planning for and implementing a faculty development program, (5) training faculty or administrators from colleges in the use of faculty development methods and instruments, (6) providing conferences and workshops on topics of common interest to faculty from several colleges, (7) helping colleges to evaluate and disseminate learnings from an on-going faculty development program, and (8) conducting inter-institutional research projects to further the higher education community's general understanding about teaching and learning, and faculty growth and development. Following is a brief description of each type of activity with one or more examples of a program of this type being conducted by a regional or national agency.

While individual consultation with faculty on a campus is usually not appropriate, a regional or national agency can be of significant assistance in providing consultation to an academic department or division, a program staff, a faculty committee or even an entire faculty. At the College Center of the Finger Lakes (CCFL) in Corning,New York (a consortium of small, independent colleges) this type of organizational consultation has been offered by both staff and consultants with considerable success. In many instances, an external person can provide more effective and objective consultation on problems that involve many people in the institution than can an internal person.

This type of service may be more appropriate for a consortium than a national higher education association or funding agency; however, virtually any direct service by a national agency will

inevitably involve some small or large group problem-solving (organizational development). The Council for the Advancement of Small Colleges (CASC) has effectively provided this type of service through its faculty development mentorships (See Appendix F) and its Title III Comprehensive Institutional Development program (the Small College Consortium). The national-level Strategies for Change and Knowledge Utilization (SCKU) project, which was funded by the National Institute for Mental Health in the early 1970's, also provided direct organizational development consultation to participating colleges (Lindquist, 1977).

Perhaps the most successful activity provided by inter-institutional agencies has been the intensive, residential workshop for faculty (see Appendix G for a description of this type of workshop). Several regional consortia offer this service: CCFL, Great Lakes College Association (midwest colleges) and the Seattle Area Faculty Development Consortium (newly-formed group of small, independent colleges and large, state-supported universities). At a national level, CASC, the Project for Institutional Renewal through the Improvement of Teaching (PIRIT) (Jerry Gaff, Director; Washington, DC) and the Association for Innovation in Higher Education (Edward Stevens, Director, St. Petersburg, Florida) offer week or two-week long workshops that faculty attend to improve their own teaching as well as gain new skills as faculty development consultants.

This type of workshop is most effectively initiated by a regional or national organization, for such an agency is uniquely able to bring together faculty from a variety of institutions,

develop a cost-sharing process that significantly reduces per-institution expenses, and attract major, national consultants. The intensive, residential workshop is one of the few services that such an agency can provide which will have a tangible and personal impact on individual faculty members in their daily professional lives. If such a workshop is followed up with on-campus services being provided by local resources, then the impact of the intensive workshop can be even further amplified.

One of the traditional and certainly most important activities which regional and national agencies in higher education can provide is the promotion, planning and implementation of programs for the exchange of human and physical resources. Many consortia have provided mechanisms for the exchange of faculty, student credit hours or equipment across campuses. Cooperative inter-campus programs have also been established that further the development of both students and faculty. CCFL, for instance, offers courses in the Bahamas on such topics as marine ecology, field archeology and the cross-cultural study of values. These courses could not have been financed by any one of the CCFL colleges.

CASC has recently initiated an inter-campus exchange program which will even more effectively promote faculty, as well as student learnings. Several times per year, CASC will offer an experimental college that is created for a short period of time (two weeks to two months) then is dissolved. The learnings of faculty (from CASC colleges) who will teach in the experimental college are as important as the learnings of students (also recruited from CASC colleges). The CASC Experimental College

becomes a testing ground for new curricular ideas or a training ground for the development of new instructional skills. Students will serve not only as learners, but also as diagnosticians, co-designers and evaluators. The Experimental College faculty, in collaboration with other members of their home college, will develop a plan for the on-campus dissemination and use of learnings from the experimental college.

Several national agencies have supported the creation of networks for the dissemination of information about human and physical resources, thereby promoting the exchange of these resources and faculty development in general. NEXUS (American Association for Higher Education: AAHE), Resources for Planned Change (American Association of State Colleges and Universities) and the National Consulting Network (CASC) exemplify this approach.

The fifth service, assistance in planning for and implementing faculty development programs, has been provided by many national associations. AAHE offered a series of national and regional conferences on faculty development in 1974 and 1975 which served as catalysts for the faculty development movement in subsequent years. CASC and PIRIT provide not only national conferences, but also on-campus consultation to colleges in their design of faculty development programs. A national agency can provide a staff member or consultant who not only holds a detached perspective about the needs and resources of the college or university, but also can bring prestige (legitimization) and insight from knowledge of numerous other faculty development programs.

While assistance in the planning and implementation of a faculty development program can be of value, a regional or national agency can be of even more help if it assists in the

design and implementation of a training program for faculty development practitioners. The state-of-the-art, as noted above, is sufficiently advanced (though disorganized) that a new practitioner can make significant use of existing knowledge in the field and training in skills associated with faculty development. CASC has offered an extensive training program for forty-five faculty from CASC colleges (See Appendix F for a brief description of this program). Other training programs are now available through the Professional and Organizational Development (POD) Network for Higher Education (Mary Lynn Crow, Director, University of Texas at Arlington) and, to a more limited extent, the NTL Institute (Washington DC). Training programs of a more specific nature (instructional design and development) are offered by Syracuse University (Robert Diamond, contact person) and Michigan State University (Larry Alexander, contact person).

A national association or funding agency can influence the quality of professional development services for faculty through a training program. Extensive evaluation of the CASC training program reveals that faculty and administrators at the participating colleges tend to respect the newly-acquired knowledge and skills of the faculty trainee and make effective use of this person. CASC also discovered that it was able to have a significant impact on the teaching-learning processes at many of the participating colleges.

Another faculty development service which many regional and national agencies provide is the conference or workshop on a topic of interest to faculty from several different institutions. CASC, for instance, has offered a series of regional and national

conferences on curricular reform which have been attended by CASC college faculty. The NSF Chautauqua conferences also fit into this category, as do the regional curricular conferences conducted by AAHE under the sponsorship of the National Endowment for the Humanities (NEH). Both the NSF and NEH conferences have been particularly successful because they are regional and reflect the current interests of faculty.

The final two services to be described concern the promotion of research and development activities in the field and the establishment of effective vehicles for the dissemination of learnings from these activities. First, a regional or national agency can help a college or university evaluate and learn from its faculty development program. CASC has provided "illuminative evaluation" (Parlett and Dearden, 1977) services to twenty-eight of the colleges participating in its Advanced In-Service Faculty Development Program. This "formative" model of evaluation focuses on what the impacts of the program (expected or unexpected) have been and why they occurred, rather than on the issue of whether or not a particular desired outcome has occurred. Jerry Gaff and consultants to the PIRIT project are providing similar services to participating colleges through the provision of expert advise on evaluation design and instrumentation, and on-campus interviews with key administrators, faculty and program participants.

A regional or national agency can also help a college or university disseminate its learnings about faculty development through many different forums: national or regional conferences, publications, resource networks, intercampus exchange of program participants and/or faculty development practitioners,

short-term consultations at other colleges by members of the program staff, low-cost off-campus consultation (via telephone or satellite-transmitted closed-circuit television), or a training-of-practitioners program.

Finally, the promotion of faculty development services can take place if a national agency supports, sponsors or funds an inter-institutional research project on faculty development. The most notable project of this type to date is SKCU. Jack Lindquist and his colleagues studied planned change and knowledge utilization at more than a dozen colleges and universities of widely divergent size and character, in order to derive general principles concerning these processes. Such a project, of comparable scope and with an equally-talented staff, is needed to study faculty development practices. A recent ETS project, conducted by John Centra (1976) and sponsored by the Exxon Foundation, represents a first step in this direction, but certainly is not adequate as a final statement. Long-term longitudinal observations (even participant-observations) are needed to build on the Lindquist work. Such a research base would be helpful to on-campus pratitioners, regional and national organizations and funding agencies as they plan for future directions in faculty development programming.

F. SUPPORT FOR FACULTY DEVELOPMENT BY FUNDING AGENCIES

At present, several general observations can be made about the role played by most national-level funding agenices in the promotion of faculty development efforts: (1) the funding agencies tend to provide funds for <u>projects</u>, based on the merit

of the proposal, rather than for people or organizations, based on the past or potential ability of this person or organization to effect needed change in the institution; (2) the funding agency rarely intervenes directly in the life of the funded institution except to provide "summative" (judgmental) evaluations; (3) some funding agencies conduct or sponsor national or regional conferences on faculty development for the dissemination of information about funded projects, for the presentation of new concepts, or for the discussion of issues that are of concern to the agency; and (4) several funding agencies are becoming increasingly concerned about the dissemination and use of learnings from and products of faculty development projects that they have funded. We will briefly discuss each of these four general observations, then briefly discuss current NSF programs.

Virtually all funding agencies that currently support faculty development programs have primarily if not exclusively funded programs rather than individuals or organizations. Probably the most notable exception has been the Danforth Foundation Fellows program which provides individual faculty members with conferences and funds for the development of campus projects.

From research on diffusion-of-innovation (Lindquist, 1977) we know that people often are more important than ideas when it comes to implementing a new program. Funding agencies should therefore consider assessing the capacities of institutions or individuals to effect desired changes. If a person is at a critical point in an informal communication network, holds exceptional credibility with a certain faculty population, is skillful in understanding the complex dynamics of a specific

kind of organization or institution, and/or is skillful in planning for or implementing a certain kind of change, then he might receive funds for a specific project or support (training, release time, assistance) for his current work. Alternatively, the foundation might support an apprenticeship program so that other people can learn from this individual, or an evaluator-researcher might be assigned to this individual to determine the nature of his impact and the reasons for his effectiveness. A similar case could be made for the funding of a specific college or university which is situated at a critical juncture in a knowledge dissemination channel (not necessarily at the entry point to this channel--as is usually the case with prestigious research-oriented universities).

A second general observation concerns the lack of direct intervention by the staff of funding agencies. While it is usually inappropriate for a funding agency to become directly involved in the daily operations of a program, it is equally inappropriate for the agency to limit its interventions to summative evaluations. The agency staff, or consultants to the agency, should be involved in formative evaluation: they should provide members of the program staff with observations, diagnoses, recommendations and hypotheses that can be of value in the improvement of the program.

The formative function enables members of the agency staff to gain a more accurate and detailed understanding of the program they have funded than is possible when they only read a yearly or final report of the program staff or when they make a summative on-site visit once a year. With more frequent, formative visits, the staff can become increasingly insightful about

the processes of change and knowledge utilization on a college campus, thereby becoming more effective in the assessment of new proposals and, in turn, more effective in subsequent formative (and summative) evaluations of programs that are funded.

Formative evaluations of faculty development programs have been conducted for the Lilly Endowment by Malcolm Parlett (Parlett and Dearden, 1977). Using "illuminative evaluation" procedures, Parlett was able to provide the foundation and program staff with new insights into the dynamics of the program and its relationship to the milieu of the institution. This evaluative process might have been even more profitable if one or more members of the foundation staff had joined Parlett in conducting the evaluation.

The chancellor's office of the California State University and Colleges system has recently hired one of the authors of this report (William Bergquist) as a part-time consultant-evaluator for several innovative programs that it has just funded. Bergquist will provide evaluative services to the campuses while also being actively involved in helping each program staff plan for and design its innovative program. Members of the chancellor's office staff will occasionally work directly with Bergquist during his visits to the funded campuses, in order to learn more about the program, to add their own considerable insights, and to break down the typical isolation and alienation between a program staff and representative of the funding agency.

Our third observation, that national and regional conferences are fairly common faculty development activities of national

funding agencies, reflects the dominant concern of these agencies with the dissemination of new ideas and innovations. Conferences and workshops are certainly an essential ingredient in any dissemination process, as are publications and demonstration projects. The most important step in a dissemination process, however, does not take place at a conference, in a book or on another campus; rather, it takes place on the home campus of the person who has heard about or read about the idea. This person needs help in developing and implementing strategies for effective on-campus dissemination. Funding agencies must become increasingly sensitive to this on-campus follow-up. By devoting part of a conference to planning for backhome implementation, the dissemination process becomes more effective. Low-key, on-campus or off-campus (telephone, closed-circuit television) consultation is often even more useful. There must also be increased concern for the problems of use, once the new idea or innovation has been disseminated--which leads us to the fourth observation.

Funding agencies are becoming increasingly concerned about the fact that many of the projects they support as experiments or demonstrations have not had a significant impact on programs at other colleges and universities. Among agencies that support faculty development programs, the Kellogg Foundation has probably done the most about this concern. This foundation has initiated a major program to assist the staff of successful faculty development projects (that Kellogg previously funded) with the effective dissemination and use of learnings from and products of these projects. The staff for this Kellogg program (headed by Jack Lindquist, University of Michigan) is trying to understand the

ways in which new faculty development practices gain acceptance and become integrated with the ongoing activities of a faculty development program.

When we turn specifically to the National Science Foundation, several general observations can be made. First, the activities of NSF clearly reflect the dominant interest of science and engineering faculty in keeping up with their discipline and restructuring their courses. The TIAS program is oriented toward the preparation of young scientists in their discipline. The Chatauqua short courses are primarily concerned with new developments in the discipline and with new instructional designs. The CAUSE, ISEP and LOCI programs are primarily concerned with course or curricular redesign and/or with the use of new equipment or more effective use of traditional equipment.

Second, NSF programs are primarily focused on the professional development of faculty. These programs relate to faculty as instructors, researchers, and scholars, but seem to be less involved with personal and organization development aspects of faculty development. Only in the case of the Women in Science program does there appear to be a dominant concern for the more personal aspects of the science or engineering faculty member's professional life. There is also apparently no NSF program which deals directly with organizational and institutional dysfunction as it effects the faculty member's professional performance or the implementation of instructional innovations.

Third, the National Science Foundation has clearly opened the door to new and innovative approaches to the evaluation of

programs it has funded. The 1977-78 program evaluation proposals that have been requested by NSF will hopefully meet the need for flexible and formative approaches to the study of a complex social process--faculty development. If the NSF staff can be actively involved in at least some of the formative evaluations, then potentially both they and the program staff will gain new insights into the nature of change and instructional innovation in contemporary colleges and universities.

G. RECOMMENDATIONS FOR THE NATIONAL SCIENCE FOUNDATION

In writing this paper, we have not viewed our primary task as being one of making specific recommendations to NSF. This would be presumptuous, given our lack of knowledge about the emerging goals and priorities of this agency. Rather we have tried to provide several different perspectives on faculty development which are suggestive of new program initiatives for the NSF. The NSF staff and advisors must draw out those implications that seem most appropriate to NSF given its context and mission. Several concerns, however, stand out as we bring this paper to a close. These concerns should be given serious consideration by NSF and should be directly related to NSF program initiatives and priorities. We have summarized these concerns in the following list of eight program recommendations:

Recommendation One: In recognition of the influential role played by disciplinary organizations, we suggest that NSF encourage these organizations to experiment with alternative delivery systems (other than conventions, conferences and publications) for disciplinary updating. The delivery systems might include video cartridges, audio cassettes (for home, office and

car), satellite-transmitted closed-circuit television (now used for continuing education in medicine) and public television.

Recommendation Two: The National Science Foundation should provide more support for those professional societies that are dedicated to education: for example, the American Association of Physics Teachers, the National Association of Biology Teachers, the Education Division of the American Chemical Society and the Association of Education of Teachers in Science. These associations should be encouraged to explore new approaches to instructional development, to become acquainted with advances in the field of faculty development and to work more closely together. A recent conference was held at the Wingspread Conference Center in Racine, Wisconsin, on the role of faculty development in the humanities (co-sponsored by the Johnston Foundation and the Society for the Study of Values in Higher Education). A comparable conference might be conducted on the role of faculty development in sciences and engineering (co-sponsored by NSF and the Johnston Foundation). Participants might include representatives from the professional science and engineering education societies as well as practitioners in the field of faculty development.

Recommendation Three: NSF should continue to sponsor research on educational processes in the sciences and engineering. Educational research in the disciplines must gain more status. It is entirely appropriate for a teaching-oriented college or university to sustain and encourage research on the educational processes of the institution. NSF support for some of the journals on research in science teaching might be helpful. Perhaps of even greater value would be NSF support for articles on

educational research that are published in the major, research-oriented disciplinary journals. There must also be program initiatives that encourage non-traditional means for the dissemination and use of the findings from this research.

Recommendation Four: Alternatives to the traditional sabbatical programs for faculty must be explored. Faculty often do not want to leave their home town for a year; nor are sabbaticals very frequently found to be of significant value, unless carefully planned by both the faculty member and colleagues who might make use of learning from the sabbatical. Professional growth contracts can maximize the value of the sabbatical. Shorter sabbaticals might be tried. For example, the one to two-week intensive workshops that are described above and in Appendix G, if carefully designed, can yield as significant an impact as the loosely planned semester or year-long sabbatical. Instead of a sabbatical a faculty member might be given support for an assistant to help out in the first semester of a newly-designed course or to evaluate the effectiveness of this new design.

Recommendation Five: NSF can help faculty in small colleges and teaching-oriented universities to increase their self-esteem and be of increasing value to their community, by promoting their use in solving problems of the local region. In the State of California, for instance, small college faculty who specialize in horticulture could help towns to select plants for parks and roadways that need little water. Also, engineers could be used on a regional basis for designing solutions for rather local problems.

The small colleges and teaching universities that cannot afford expensive equipment might, in turn, be assisted by business or public service organizations that have equipment and

laboratory space available at certain times for use by faculty and students. NSF could help get these exchange programs off the ground and sustain them for a year or two until logistical problems are solved, and mutual trust and credibility is established.

Recommendation Six: NSF should consider a program for the training of faculty development practitioners in the sciences and engineering. Highly respected faculty from different kinds of institutions could be identified and recruited, based on their central position in a college, disciplinary association or informal communication network; their professional interest in science or engineering education; and their personal commitment to working actively with other faculty members. These potential practitioners, with demonstrated support from their home institutions, would be provided with training in a variety of faculty development practices (for example, instructional diagnosis and instructional design consultation) and would apprentice with another faculty member (mentor) from a comparable institution who has already become a successful practitioner. The training program should incorporate personal and organizational as well as instructional development practices.

Recommendation Seven: NSF should help finance research on and discussions about the developmental needs and motivations of faculty in the sciences and engineering. We are still ignorant about these issues, and will never be able to adequately design faculty development programs to meet these diverse and complex needs unless we more fully understand them.

Recommendation Eight: Over the next ten years, the greatest challenge that will be faced by faculty development practitioners,

and other faculty and administrators who are interested in the welfare of faculty, is the design and implementation of programs for faculty who must undergo significant career transitions. There are at least five levels of change that many science and engineering faculty will face during the coming decade (See Table 7). While the first two or three of these levels can be handled within the context of current faculty development practices (with the assistance of an agency such as NSF), the last two or three levels require new programs and even new institutions.

Retraining institutes probably will have to be established independent of existing colleges and universities, for the politicization and resistance associated with a retraining program would immediately destroy or distort this very subtle process. The institute staff will have to develop or help a college initiate processes for the assessment of current and potential faculty resources and needs. If faculty are to be encouraged to shift disciplines (level four) or leave higher education entirely (level five), then their skills, aptitudes and interests must be assessed to determine which other disciplines or occupations might be most compatible.

Disciplinary and occupational retraining must incorporate rapid and highly efficient procedures for the acquisition of the essential knowledge and skills in the discipline or occupation; in addition this new expertise must be fully integrated with past experiences and expertise so that the faculty member might provide a distinctive and highly valued interdisciplinary perspective, as one who is knowledgeable in at least two fields. Disciplinary retraining should also include a series of sessions on course

design and instructional methodology. Even though the faculty member might be able to use the same designs and methods that he used in his previous discipline, this retraining period provides an excellent opportunity for the faculty member to consider new instructional strategies and thereby become even more effective as a teacher and valuable to his new colleagues.

The institute must provide the faculty member (and family) with a supportive environment for the retraining process. Life and career planning and supportive counseling should be offered to those faculty who want or need it. The institute should be designed to maximize the faculty member's sense of self esteem, as well as the esteem that will be assigned to him by his new colleagues. The faculty member should be introduced to some of the most prestigious and exciting thinkers in the new field and should be encouraged to become a creative thinker in his new field (with the valuable perspective of his second discipline).

This type of retraining program will be very difficult to design and implement. Members of the institute staff will have to work closely with not only the faculty member who is being retrained, but also the academic department or new employer with whom the faculty member will be working. NSF should seriously consider the sponsorship of a demonstration program of this type for faculty in the sciences and engineering.

These eight recommendations represent some of the more interesting or particularly important directions in which NSF might move in its attempt to assist science and engineering faculty in

their continuing development. Some of the recommended programs can be rather easily implemented; others, such as the last one on faculty retraining, will take considerable time and resources. Hopefully, some of these recommendations and recommendations that emerge from the previous general discussion will be both feasible and significant.

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